



# NWT CANGROW REPORT

## **Assessing the Feasibility of Establishing a Commercial Greenhouse in Norman Wells, NT**

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# Executive Summary

This report provides the results of the NWT CanGrow Greenhouse Feasibility study for the Norman Wells case study. The feasibility study adapted tools and techniques for designing a commercially viable greenhouse for use in a northern setting. The study focused on addressing the community first – including local preferences, demand and growing conditions – and developing greenhouse design and business model planning around these community factors. The research team used in-depth feasibility analysis to develop recommendations for operating a successful commercial greenhouse in each community.

This report uses the data collected in Norman Wells to assess community readiness, make design recommendations, calculate the commercial feasibility of the endeavor, and assess the contributions that a commercial greenhouse can make as a social enterprise. The results reported refer to the first year of the proposed operation and guidance for expanding the operation in future years is provided throughout the report.

The proposed greenhouse would be 2160 sq ft. Hydroponic systems with built-in drip irrigation would be used to grow crops and radiant heating would be used to maintain temperature. A forced air ventilation system is required to circulate air and maintain temperature.

The report finds that a moderate revenue could be generated by a commercial greenhouse in Norman Wells. The most significant costs in the first year will be start-up costs. A large capital investment is recommended to establish the greenhouse and install an energy efficient radiant heating system. The proposed greenhouse would have the capacity to extend the growing season, offset imports and generate \$59,656 in profit from sales in the first year.

Recommendations discussed include:

1. Greenhouse Design

The proposed greenhouse is a 30ft by 72ft by 18ft arched greenhouse with 10ft sidewalls, polycarbonate end walls and double door entryway with a polyethylene glazing.

2. Crop Selection

While the greenhouse design allows for plenty of room for expansion, the recommendation is to start with 8 -10 crops: tomatoes, bell peppers, cucumbers, basil, cilantro, thyme, baby spinach, mixed greens, butter lettuce and romaine.

3. Growing Schedule

The greenhouse design and proposed crops would be best served by a growing season that starts in April and ends in October.

4. Markets

In its first year, the greenhouse is designed to grow enough produce to supply local catering company (Royal Mackenzie Catering) and a weekly Community Supported Agriculture (CSA) box for about twenty

members. In future years, the CSA membership can be expanded.

5. Heating

Two heating systems have been assessed for feasibility: forced air and radiant heat. If the capital money is available radiant heat is strongly recommended to reduce energy costs.

6. Growing System

Hydroponic vertical growing towers and bato buckets are recommended because soil is not a readily available resource in Norman Wells, and shipping enough soil for a greenhouse of this size would be less efficient than growing without soil.

7. Bedding Plants

Bedding plants are a great source of revenue, as they are sold early in the year at a profit, leaving room to start other crops. It should be noted that a spring bedding plant sale would compete with the existing commercial greenhouse's spring bedding plant sale.

8. Raised Beds

Permafrost zones vary widely in Norman Wells, therefore raised beds would be required for in-ground growing. While there is high demand for root vegetables, like potatoes, carrots, and onions, raised beds are not an efficient growing option for a greenhouse that would have to ship soil.

The study concludes that a commercial greenhouse designed according to the proposed model could be feasible in Norman Wells, particularly if funding was accessed to assist with start-up costs, especially equipment and capital. There is enough local support and demand for fresh produce, and it is possible to design a greenhouse that will be highly productive without accumulating high annual costs.

# Table of Contents...

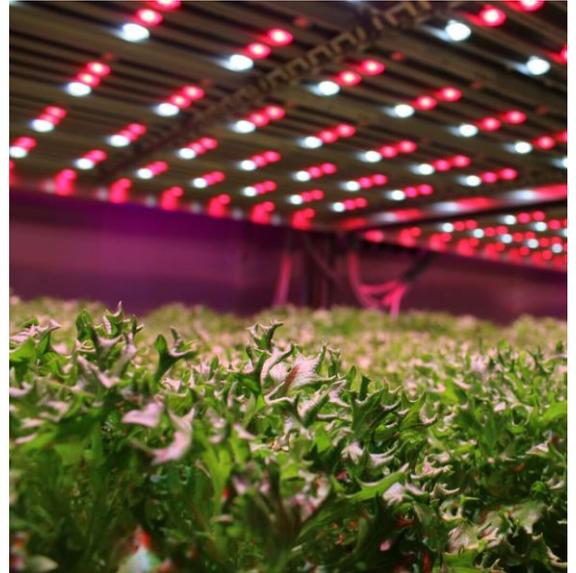
## Table of Contents

<b>Executive Summary</b> .....	<b>1</b>
<b>Introduction</b> .....	<b>4</b>
Project Overview.....	4
Reading the Report .....	4
<b>Part 1: Assessing Community Readiness</b> .....	<b>5</b>
Investigating the Market.....	5
Estimating Demand.....	6
Bedding Plants.....	7
Pricing Produce .....	8
<b>Part 2: Design Planning for a Feasible Greenhouse</b> .....	<b>11</b>
Growing Systems.....	11
Glazing and Framing.....	12
Temperature Needs .....	13
Light Needs.....	14
Water Needs .....	14
Energy Needs .....	14
<b>Part 3: Accounting for a Feasible Greenhouse</b> .....	<b>16</b>
Start-up Costs.....	16
Consumable Costs.....	17
Fixed Costs .....	17
Projected Sales.....	18
Total Costs and Revenues .....	19
<b>Part 4: Commercial Greenhouses and Social Enterprises</b> .....	<b>20</b>
Local Economies.....	20
Healthy Eating .....	20
Sustainable Food Systems.....	20
<b>Recommendations</b> .....	<b>21</b>
<b>Appendices</b> .....	<b>22</b>

# Introduction

## Project Overview

The Aurora Research Institute developed the *NWT CanGrow Greenhouse Feasibility Study* to find out whether it is feasible to operate a commercial greenhouse in the Northwest Territories (NWT). NWT communities are interested in improving food security, increasing access to fresh and healthy produce, encouraging positive dietary choices and creating economic opportunities in local food production. Community growing initiatives have expanded across the north in recent years and a community of growers has emerged to support the budding NWT agricultural shift.



This study was supported by the Canadian Northern Economic Development Agency and the Government of the Northwest Territories Department of Industry Tourism and Investment. Like ARI, both agencies are interested in how commercial greenhouses can improve food security, economic opportunity and quality of life in NWT communities.

The feasibility study adapts tools and techniques for designing a commercially viable for use in a northern setting. The study tools are flexible enough to accommodate the differences between communities, which range from southern boreal to the high arctic. The feasibility study is focused on addressing the community first – including local preferences, demand and growing conditions – and developing greenhouse design and business model planning around these community factors. The research team examined two case studies – Inuvik and Norman Wells – and used in-depth feasibility analysis to develop recommendations for operating a successful commercial greenhouse in each community.

In February 2016, Kimberley Sellwood conducted data collection in Norman Wells to more accurately understand the local conditions, gather information about community readiness, and seek stakeholder input on the potential for a commercial greenhouse in the community. This report uses the data collected in Norman Wells to assess community readiness, make design recommendations, calculate the commercial feasibility of the endeavor, and assess the contributions that a commercial greenhouse can make as a social enterprise.

## Reading the report

This report is intended for individuals or organizations in Norman Wells who may be involved with or are considering commercial greenhouse growing. This report is divided into four main parts: 1) Community Readiness, 2) Design Planning for a Feasible Greenhouse, 3) Accounting for a Feasible Greenhouse, 4) Greenhouses as Social Enterprise. The information provided in this document outlines the most feasible production schedule based on the feedback about produce needs, as sourced from community members, food retailers, organizations and institutions who are key players in the local food economy. It proposes a greenhouse design that can accommodate the production schedule that the community requires. It provides an overview of the projected costs and revenues that can be expected from the proposed greenhouse. Finally, the report considers the wider benefits that a commercial greenhouse can have within the community, as reported by local stakeholders.

# Part 1: Assessing Community Readiness

*The benefits of a local greenhouse are often quite apparent to those who hope to establish greenhouses in NWT communities. The community readiness assessment explores whether there is demand for a greenhouse in the wider community and whether the local markets can support the proposed operation.*

## Investigating the Market

Surveys and interviews were employed to explore the potential produce markets in Norman Wells. An online survey was circulated on Facebook and in-person to determine demand for fresh produce and interest in supporting a commercial greenhouse in the community. In total 91 surveys were collected, and interviews were conducted with the two grocery stores, one catering company, and the K-12 school that administers a subsidized foods program.

Even though the produce prices in Norman Wells are exceptionally high compared to more accessible regions in the north, community members surveyed still indicated they would be willing to pay a bit more for fresh, locally grown produce.

Royal Mackenzie Catering is a high volume catering company providing meals for 200 people a day at four locations. The owner reports that they order 1 ½ pallets of produce twice a week. Royal Mackenzie currently orders produce from Ramparts, but would be interested in amending her produce order to support a commercial greenhouse in Norman Wells.

Norman Wells residents who responded to the survey were strongly in favour of purchasing locally. Community Supported Agriculture (CSA) memberships provide an opportunity for community members to support local agriculture and receive a weekly box of fresh produce. A CSA is an agreement made between the grower and the customer to purchase a weekly subscription of produce. The rate for the veggie box is set in advance and full payment is taken at the beginning of the season, when growers need a large injection of funds to float seed and supply purchases. Weekly vegetable subscriptions are not only a consistent source of revenue, but can be expanded annually until your greenhouse achieves its growing capacity.

While the other local restaurants were not available to participate in the large volume customer interviews due to time constraints, it is advisable that a local grower pursue contracts with these markets. If the grower is able to come to an agreement, with the local restaurants amending crop production for the first year in lieu of a CSA membership is advisable.

The local grocery stores also provided feedback. The produce manager at the Northern store reported that, as a chain grocery store, they would not likely be able to purchase locally produced food. There is an opportunity for further discussion with upper management, once the greenhouse has a few seasons of production data demonstrating its capacity to provide fresh, consistent volumes of produce. In terms of market share, the Northern brings in two pallets of produce twice a week.

Ramparts, the independently owned grocery store in Norman Wells, brings in one pallet of produce twice a week. The produce manager reported that there may be an opportunity to supply the grocery store if the cost was competitive with southern suppliers, but the final decision would rest with the

owners. While the store is not included in the production schedule proposed in this report, excess yields at the end of each week could be sold to the store at below direct sale value.

Norman Wells does not have a local farmer’s market. However, it would be just as effective for a greenhouse operation to establish its own on-site, direct sales market on the weekend to sell excess crops after all other market obligations have been fulfilled.

**Table 1:** Selected results from online community readiness survey (Norman Wells, NT)

Statement	Agree OR Strongly Agree	Neutral	Disagree OR Strongly Disagree
Very fresh fruits and vegetables are not usually available for me to buy.	70%	15%	15%
I would be willing to pay a little more for very fresh produce.	66%	16%	18%
I will buy fruits and vegetables wherever they are the cheapest, even if the quality is lower.	8%	17%	75%
I think fruits and vegetables should be grown locally.	58%	33%	10%
I would support a local business that sells fresh fruits and vegetables.	95%	4%	1%

### Estimating Demand

Survey and interview data were analyzed to determine which markets are the most viable for immediate development, as well as those that do not seem like they would generate a reasonable revenue stream. In Norman Wells, the best market to supply in the first year of business, would be the local, large volume catering company Royal Mackenzie Catering. Also, with the goal of increasing its membership every year, a weekly vegetable subscription for 20 members is also incorporated into the crop production schedule.



Survey results show that community members are interested in some greenhouse produce, but also some produce that is better grown in-ground growing or raised beds. Greenhouse operations may consider adding beds inside or outside to expand capacity to support other crops.

**Table 2: Likelihood of purchasing produce by crop (Norman Wells, NT)**

Item	Always & often	Seldom & never	Top ten crop?	Top five crop?
Beans	62%	38%		
Beets	43%	57%		
Broccoli	96%	4%	Yes	Yes
Cabbage	57%	43%		
Cauliflower	78%	22%		
Cucumbers	86%	14%		
Carrots	93%	7%	Yes	Yes
Eggplant	22%	78%		
Garlic	82%	18%		
Kale	64%	36%		
Kohlrabi	21%	79%		
Leek	34%	66%		
Lettuce	93%	7%	Yes	
Mixed Greens	95%	5%	Yes	Yes
Onions	94%	6%	Yes	Yes
Peas	80%	20%		
Peppers (bell)	92%	8%	Yes	
Peppers (hot)	55%	45%		
Potatoes	91%	9%	Yes	
Radishes	33%	67%		
Spinach	87%	23%	Yes	
Swiss Chard	30%	60%		
Tomatoes	89%	11%	Yes	
Turnips	54%	46%		
Zucchini	65%	35%		
Strawberries	92%	8%	Yes	Yes
Fresh Herbs	83%	17%		

Based on the results of the customer demand surveys and the reported demand from local restaurants, the proposed crops for the Norman Wells greenhouse are: tomatoes, cucumbers, bell peppers, herbs, spinach, mixed greens, green lettuce, and romaine.

### Bedding Plants

Seventy-five percent of those surveyed said they were unaware that bedding plants were available for sale in the spring from the local commercial greenhouse. Fifty percent of those surveyed said they would buy bedding plants if they were available for purchase. This suggests a need for more strategic marketing, but also indicates there is room for growth. A commercial greenhouse could amend their production schedule to sell bedding plants early in the season, before they begin selling produce. There is a lot of opportunity in this market, as a wide selection of vegetable, herb and flower bedding plants are in demand.

**Table 3: Bedding plants survey results (Norman Wells, NT)**

Item	Very Likely & Somewhat likely	Somewhat unlikely & not likely	Never
Annual flowers for pots and planters	57%	35%	8%
Annual flowers for a flower bed	52%	34%	14%
Perennial flowers	57%	31%	12%
Vegetables for a home garden	62%	29%	9%
Vegetables for a home greenhouse	55%	34%	11%
Herbs	77%	17%	94%
Berry bushes	56%	31%	13%
Shrubs for landscaping	28%	56%	16%
Trees for landscaping	28%	54%	18%

### Pricing Produce

Despite the already high prices of produce for sale in Norman Wells, more than half of the residents surveyed said they would be willing to pay a little bit more for fresh produce and only five percent of those surveyed felt the produce available is fresh (see Table 1). Generally, in the first year of operation, the commercial greenhouse need only to set prices that are close to the prices offered by current vendors in order to be competitive.

Produce in Norman Wells is in flown in twice a week. Both grocery stores reported very little lost revenue due to spoilage, but some community members reported produce tends to be soggy, as it is known to freeze during transportation. For this study, Ramparts and Northern produce prices were used as the benchmark. High-value or specialty crops, such as herbs and mixed greens are hard to transport up north, as they freeze easily. Therefore they can be sold for a premium, because they will be harvested and delivered within 24hrs; making them of the highest nutrient content and freshest produce available to the community.

**Table 4: Local market prices and proposed greenhouse pricing (Norman Wells, NT)**

Crop type	Unit type	Ramparts Grocery	Northern Store	Commercial Greenhouse
Tomatoes	Pound	\$12.59kg	47.99kg	\$10k/\$22lb
Bell Peppers	Pound	\$7.30kg	11.79kg	\$10.88kg/\$24lb
Cucumber, English	Fruit	\$4.29	\$4.09	\$4.50ea
Herbs	Gram	n/a	n/a	\$6/28gr/1oz
Spinach	Pound	\$3.99/bag	\$7.19	\$17lb
Mixed Greens	Pound	\$4.99	\$7.19	\$17lb
Green Lettuce	Head	\$4.99	\$3.15	\$5
Romaine	Head	\$4.59	\$3.35	\$5

The response from Norman Wells was overwhelmingly supportive of a commercial greenhouse. The key to moving forward is to ensure the crops made available by the greenhouse reflect the demand reported by the community. A schedule has been developed based on the information gathered in this section. Appendix C contains planning charts for each market that specify how much of each crop that market will consume each week throughout the growing season. Appendix D shows the weekly demand for each

crop from all markets – this is the total demand for each crop that the greenhouse will have to produce each week in order to supply all of the proposed markets.

Using the total number of units required each week to supply all proposed markets, the chart below summarizes the monthly activities (planting or harvesting) for each crop and number of units planted or harvested every week for the entire season. Crops are planted each week throughout the planting season and harvested each week during the harvesting season in order to provide a steady supply that matches the projected demand reported by customers.

**Table 5: Summary planting and harvesting schedule**

Month	Activity	Crop	# of Units
April	Weekly plantings begin	Baby Spinach	41
		Mixed Greens	41
		Butterhead Lettuce	41
		Romaine	41
		Herbs	50
		Bell Peppers	30
May	Weekly plantings begin	Tomatoes	123
		Cucumbers	57
	Weekly harvesting begins	Baby Spinach	41
		Mixed Greens	41
		Butterhead Lettuce	41
		Romaine	41
		Herbs	50
	Weekly harvesting begins	Bell Peppers	30
		Tomatoes	123
		Cucumbers	57

To achieve these weekly targets, the greenhouse must have sufficient area to accommodate starting enough plants, weekly, to accommodate the harvests required for all markets. Appendix E contains the planning charts for space requirements by crop. Table 6 summarizes the growing area required for the proposed greenhouse. This includes area required for seedling trays, pots, and vertical hydroponic systems in each month.

**Table 6: Growing Area Chart**

Production Months	Total Area for Trays	Total Area for Pots	Total Area for Vertical Systems	Monthly GA Req
April	73ft <sup>2</sup>		592ft <sup>2</sup>	665ft <sup>2</sup>
May	83ft <sup>2</sup>		592ft <sup>2</sup>	675ft <sup>2</sup>
June	83ft <sup>2</sup>		688ft <sup>2</sup>	771ft <sup>2</sup>
July	73ft <sup>2</sup>	220ft <sup>2</sup> *	688ft <sup>2</sup>	981ft <sup>2</sup>
August	73ft <sup>2</sup>	220ft <sup>2</sup>	688ft <sup>2</sup>	981ft <sup>2</sup>
September	73ft <sup>2</sup>	220ft <sup>2</sup>	688ft <sup>2</sup>	981ft <sup>2</sup>
October	73ft <sup>2</sup>	220ft <sup>2</sup>	688ft <sup>2</sup>	981ft <sup>2</sup>

\*220ft<sup>2</sup> is a static number for crops grown in bato buckets, as the same plants will continue to yield for the duration of the season

Hydroponic systems were chosen for the proposed greenhouse design because they are an intensive growing model that focuses on getting the highest yield out of the smallest space. Bato buckets will be used to grow tomatoes, bell peppers and cucumbers (please see Part 2 for more details.) From the demand targets identified for all markets and the space requirements for each crop, the total growing area for the proposed greenhouse is 2160 square feet. This is double the growing area required for the first year in order that crop production can be expanded in subsequent years. This will also allow area for workstations, washrooms, a point of sale area, and any other facilities that may be needed within the greenhouse itself.



# Part 2: Design Planning for a Feasible Greenhouse

*The previous section has established that there is significant support for a commercial greenhouse in the community. Part 2 explores the key design considerations that impact feasibility of commercial greenhouses. The following analysis will provide design recommendations and further planning details to ensure a feasible greenhouse.*

## Growing Systems

In order to have a feasible commercial greenhouse in Norman Wells, the proposed design plan must extend the growing season for as long as possible, while economically managing costs required to provide adequate heat and light to the crops. The objective of the proposed greenhouse design is to grow as late into the year as possible: crop production will begin in April and continue until the end of October.

**Table 7:** Summary planting and harvest dates by crop

Crop	Plant Date	Harvest Date
Tomatoes	May 1 <sup>st</sup>	Harvest weekly starting in July
Bell Peppers	April 1 <sup>st</sup>	
Cucumbers	May 1 <sup>st</sup>	
Herbs	April 1 <sup>st</sup> ; plant every subsequent Sunday	Harvest weekly starting in May
Baby Spinach	April 1 <sup>st</sup> ; plant every subsequent Sunday	
Mixed Greens	April 1 <sup>st</sup> ; plant every subsequent Sunday	
Butter Lettuce	April 1 <sup>st</sup> ; plant every subsequent Sunday	
Romaine	April 1 <sup>st</sup> ; plant every subsequent Sunday	

The proposed design incorporates two growing systems to achieve the most economical production. As mentioned, bato buckets will be used to grow tomatoes, bell peppers and cucumbers. The buckets are filled with a soilless substrate. Nutrients are dripped into the top of the buckets and excess is drained out the bottom as waste water. The remaining crops will be grown in a vertical hydroponic system made up of grow towers (when linked together on a custom rack, this system is called a ZipFarm.) Like the bato buckets, the grow towers pump nutrients through the hydroponic solution.

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Bedding plants can be an important addition to any commercial greenhouse operation. As mentioned above, the total growing area for the greenhouse is 2160 square feet, but this area is much larger than what's required to grow the first year crops. This means expending resources to heat an unused space. Using that space to grow trays of bedding plants will generate \$7-9 per square foot and ensure that valuable greenhouse space does not go to waste

Another option, if capital funding is available, would be to install separate closed system growing units that can produce crops all year-round.

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Considering the demand requirements of the proposed markets and the space required for the proposed systems, the total growing area for the proposed greenhouse is 2160 square feet. This is double the space for the first year of production, but it means there is room for expansion

## Glazing and Framing

In addition to the crop type and space requirements discussed above, greenhouse design must consider the local conditions in order to create and maintain an optimal growing environment. The glazing and framing materials were chosen after a thorough consideration of Norman Wells’ two most serious challenges: high shipping costs and cold climate.

**Table 8: Glazing and Framing Recommendations**

Item	Description	Transportation	Construction	Temperature
Kit	30’ x 72’ x 18’ arched roof greenhouse kit with 10ft sidewalls, twin wall polycarbonate end walls, double door entryway	Will transport easily in one shipment, reducing transportation costs	Designed for simple design, reducing construction costs	
Glazing	Double inflated 6mm polyethylene glazing	Much lighter than triple or double polycarbonate	Less likely to be damaged during installation, draping process can be done by the grower, avoiding high construction costs	Adequate R-value (1.7), less prone to condensation issues
Framing	Galvanized steel	Fairly light for its strength – less support framework is required – reducing transportation costs	Very sturdy, generally has less support framework, reducing construction costs	Casts minimal shadow

The proposed greenhouse would be a kit consisting of galvanized steel covered with polyethene glazing, except for two polycarbonate end walls. A triple or double wall of polycarbonate glazing offers the best insulating capability, however, it scratches easily and may not transport well. Also, if it is not properly installed, it is prone to serious condensation issues, which can cause fungal disease that wipes out crops quickly. Conversely, an inflated double wall of 6 mm polyethylene film has a similar R-value (insulating property) of 1.7 to a double wall of polycarbonate, but it is much lighter and damage-resistant.

One disadvantage of poly film is that it starts to become opaque over time, reducing light transmission and requiring replacement every 3-5 years. Still, the labour rate for replacement should be affordable because it is easy to re-glaze – many growers install the glazing themselves.

## Temperature Needs

Heating the greenhouse in Norman Wells is not only the largest annual fixed expense, but it is also the key to optimal germination rates and even plant growth. Planning for this cost is critical to a commercial greenhouse's success. Propane and natural gas are the typical fuel options for greenhouses, however these options are not available in Norman Wells, where heating oil is the primary fuel source. Seedlings will be started in the greenhouse in April and plantings will continue into September –Table 9 provides the average estimated fuel consumption per month.

**Table 9: Monthly Fuel Consumption Estimate**

Month	Average Minimum Temperature	litres/Month	Monthly Fuel Projection
April	-11.1	800	\$1.20 * 800 = \$960
May	.6	325	\$1.20 * 325 = \$390
June	9.3	150	\$1.20 * 150 = \$180
July	11.5	150	\$1.20 * 150 = \$180
September	8.4	150	\$1.20 * 150 = \$180
October	-7.7	325	\$1.20 * 325 = \$390

These estimates are general projections. The greenhouse will likely only need 24 hour heat in April. In May, September and October it will be limited to overnight and in the early morning.

The most common approach for heating commercial greenhouses is to use forced air units and fans to circulate the warm air. The most efficient recommendation for a heating system is closed-looped water radiant heating. The initial investment will be especially high, because, as mentioned, heating fuel is not the norm for greenhouses. While Norman Wells has one of the lowest commercial heating fuel prices, it is still subject to high electricity rates and long winters. Once installed, radiant heating can reduce the monthly heating bill by thirty percent.

**Table 10: Radiant Heat vs Forced Air**

Radiant Heat	
Advantages	Disadvantages
1/3 the fuel cost of forced air	Initial investment is five times more than forced air
Direct contact with soil means Increased nutrient uptake	An additional room (the storage room) would be necessary to house the boiler
Consistent temperatures equals more even crop growth	
Different temperature zones for flexible growing schedules	
Shorter production times	
Forced Air	
Advantages	Disadvantages
Minimal initial investment	It has the highest energy costs out of any system
Situated in the greenhouse, the units are hung from rafters	It is the most inefficient system, and needs additional fans to circulate the air around the greenhouse
	Hot air blown across the plant canopy is not ideal, and there is no additional heat being directed at the soil, where it is needed the most.

The system includes rubber tubing that circulates hot liquid – water or glycol are options – to distribute heat. The tubing is laid underneath a concrete floor and through benches that will support seedling trays and bato buckets, to ensure seedlings are receiving enough heat for optimal germination. The benches would be arranged along either side of the greenhouse, with the vertical growing system running through the middle. The in-floor heating, combined with the radiant heating benches, will ensure that the soil is at 21C and the air is at 16C when the outside temperature is around -13 outside. A unit heater is recommended for back-up for when the temperature drops any lower.

**Light Needs**

Some greenhouse operations make use of supplemental light to extend the season or to grow year-round. The structure proposed for Norman Wells will transmit sufficient sunlight to establish seedlings in the early part of the season. In October, the sun does not rise until 9am and it sets at 8pm. Supplemental light shouldn't be necessary, however, the grower may see a decrease in the final month yields.

By June, Norman Wells will have 24 hours of sunlight and the use of shade cloths will be essential for the cold hardy crops. Shade cloths should also be hung from both side walls in the evening to give all the crops a break from the sunlight. A typical strategy for shade cloths is to build a rack that the shade cloth is draped over, and the plants can grow underneath the cloth. This is a good option for the plants growing in the vertical system.

**Water Needs**

The current commercial rate for water in Norman Wells is .0122 cents/litre. A basic industry accepted standard for water consumption in greenhouses is 7-8 litres per square metre of growing area per day. The chart below gives the monthly estimates for water consumption for the greenhouse growing season.

**Table 11: Water Consumption Estimate Chart**

Month	Monthly GA	Estimated consumption
April	665ft2	\$60.51
May	675ft2	\$61.48
June	771ft2	\$72.27
July	981ft2	\$89.80
August	981ft2	\$89.80
September	981ft2	\$89.80
October	981ft2	\$89.80
		Total: \$553.46

**Energy Needs**

Fuel and electricity rates are the most cost prohibitive aspects of greenhouse production. Wherever possible, it is advisable to invest more money in energy efficient infrastructure up front and reap the benefits of a lower monthly energy consumption. This does require significant capital funding at the outset.

Electrical needs are estimated to consume approximately 10 – 15 percent of a growers total energy bill. The proposed greenhouse operates using three main systems: hydronic radiant heating, drip irrigation, and forced air ventilation. Table 11 outlines the electricity used by each system.

**Table 12: Energy Use by System**

Item	Rate of Use	# of Systems	Cost Per Hour	Annual Projected Energy Costs
Hydronic radiant heating	Fulltime heating in spring and winter	2	\$.91/hr	\$2628
Unit Heater	Back up for temperature drops	1	\$4.40/hr	\$88
Drip irrigation	15 minute drip cycle twice a day	2	\$3.52/hr	\$739.20
Forced air ventilation	In summer one air exchange per minute	1	\$0.80/hr	\$900
	In winter 3 per hour			
			Total: \$4355.20	

The energy use by these systems accounts for the minimum energy use for the greenhouse operation. If additional systems and appliances are added – for example, a computer system, a cash register, lights, power outlets, etc. – they will need to be factored in to the overall projected energy use.

The design recommendations in this section are closely tied to the local conditions and the needs of the crops that will be grown in the proposed greenhouse. A careful design outline has provided the necessary information to account, in detail, for all costs associated with the construction and operation of the proposed greenhouse operation. The next section will present a snapshot of the expected costs and revenues.



## Part 3: Accounting for a Feasible Greenhouse

The previous section outlined the most efficient greenhouse design for the conditions in Norman Wells. Part 3 identifies the proposed greenhouse's expected costs and possible revenue sources. The goal is to propose a greenhouse with balanced costs and revenues by limiting costs and maximizing efficiency.

### Start-up Costs

The start-up costs for the proposed greenhouse include the purchase of all materials, systems, equipment, supplies and construction costs (including labour). Table 12 outlines, in detail, the start-up costs associated with the proposed greenhouse.

**Table 13: Start-up Costs**

Category	Item	Cost*
Greenhouse structure	GrowSpan Series	\$17,104.55
	End Frame Kit	\$1,588 * 2 = \$3,176
	Clad kit	\$1576.56 * 2 = \$3,153.12
	Rafter kit, posts	\$468.31 * 6 = \$2,809.86
	Rafter Support	\$207.42 * 5 = \$1,037.10
	Dbl swinging door	\$859.55
Growing System	Dutch Bucket System	\$8,843
	Integrated Panel	\$2,459.45
	Timer	\$65.17
	ZipGrow Commercial Bundle	\$9,450
	ZipGrow Media pulling hook	\$29.99
Radiant Heating System	In-floor & Bench	\$12,725.60
	Fuel Oil Boiler	\$6,025
Unit Heater	Optional for colder nights	\$1,150.68
Ventilation	Fan 20"	\$189.12 * 4 = \$756.48
	Slant wall fan	\$1081.64
	Aluminum Shutter	\$384.90 * 2 = \$768.80
Irrigation	Seedling watering system	\$200
Workspace	4'w x 8'L Workbenches	\$338.34 * 23 = \$7781.82
Storage, Harvest and Processing	Produce Fridge	\$13,087
	Reusable harvest Containers	20 * \$19 = \$380
	Reusable harvest Containers	20 * \$19.95 = \$399
	Salad Spinner	\$145
	S/S Washbasin work surface	\$1181
Greenhouse Labour	\$50-\$75 unskilled/skilled labour	260 hrs * \$75 = \$19,500
ZipGrow Operations Systems Installation	Upstart Farmers Support Package included	N/A
Radiant Heat System Installation	175 man hours – 9-10 days with 2 people working 10 hour days	\$75/hr = \$13,125
Shipping	FarmTek	\$9,956
	ZipGrow Canada	\$400
	Hendrix Restaurant Supplies	\$335.61
	Delta Radiant Heating	\$1,100
Customs		TBD
Total		\$139,086.42

Start-up costs are the largest expense that a greenhouse operation will have to account for. Ideally, much of this cost would be covered by a funding injection, to reduce the financial burden on the grower and improve their chances for success. If capital funding to cover start-up costs cannot be found, the operation may still be feasible, provided the total start-up costs are not exorbitant.

## Consumable Costs

Once start-up costs are accounted for, consumable item costs must be considered. This includes all direct inputs (planting containers, substrate, seeds, etc) and costs associated with sales (packaging for produce, storage, marketing, etc).

**Table 14:** *Consumable Item Costs*

Consumable Item Cost	Description	Cost
Containers	Seedling trays	\$42.20
Growing Media (substrate)	Delta 6 Block	\$360.11
	Ziptower FlexiPlugs	\$69.00
Plugs, cuttings, seed	Seed	\$2,000
Tags, Stakes, Trellis, Etc.	Trellis Kit	\$325.50
	Tomato Roller	\$402
	Tomato Clips	\$66.36
Fertilizer		Included in first year hydroponic bundles
Electrode supplies		\$208.43
Chemicals – Pest Control, PGR		Included in first year hydroponic bundles
<b>Total Variable Costs</b>		<b>\$3,196.17</b>

## Fixed Costs

Fixed costs are expenses you pay monthly or annually – the bills. The previous section of this report estimated fuel use for heating the greenhouse, electricity needs and water needs. These needs translate directly into estimated fixed costs. The chart below estimates the fixed costs for the proposed greenhouse during production months – please note, the greenhouse is only in operation for seven of twelve months. Annual costs have been divided amongst the seven months of operation.

**Table 15:** *Fixed Costs*

Expense	Monthly Cost	Annual Cost
Greenhouse Property Loan	Unknown	Unknown
Property Taxes	\$163.57	\$1,145
Insurance	\$357.14	\$2,500
Water	\$571.42	\$4,000
Energy	\$622.17	\$4,355.20
Fuel	\$180-\$960	\$2,280
Depreciation	\$871.42	\$6,100.15
Labour	\$500	\$2,068
<b>Total</b>	<b>\$4445.72 - \$3265.72</b>	<b>\$22,448.35</b>

**Property Taxes/Leases:** a mill rate of 17.62 was used to calculate the estimated property tax of \$65,000

**Insurance:** is a rough estimate for total liability

**Water:** see Table 12 for a breakdown of water estimates

**Energy:** estimated total cost for all systems calculated together for the entire season

**Fuel:** the total cost for natural gas for the season minus 30 percent savings anticipated with radiant heating system.

**Depreciation:** projected depreciation value of all equipment divided by expected lifespan.

**Labour:** The scale of greenhouse proposed in this report is large enough to need seasonal employees. The range of duties could span the entire season, from planting, to maintenance to harvesting and delivery. An estimate of 25 hours a week at \$20.28/hr was used.

### Projected Sales

Sales revenue is the profit the greenhouse operation generates from selling produce, and is calculated annually. Table 17 presents the projected annual revenue from each crop, based on the prices and unit targets set in the community readiness section.

**Table 16:** *Projected Sales Revenue Chart*

Crop	Price per Unit	Total Units	Projected Annual Sales
Tomatoes	\$22/lb	704lbs	\$15,488
Peppers	\$24/lb	272lbs	\$6,528
Cucumbers	\$4.50/ea	704	\$3,168
Herbs	\$6/28gr/1oz	940 1oz bundles	\$5,640
Baby Spinach	\$17/lb	488lbs	\$8,296
Mixed Greens	\$17/lb	488lbs	\$8,296
Butter Lettuce	\$5	1224 heads	\$6,120
Romaine	\$5	1224 heads	\$6,120
Total projected Sales:			\$59,656

See the appendix for the total revenue chart. It denotes the different areas revenue can be sourced from, which would help offset capital costs.

## Total Costs and Revenues

In its first year, the proposed greenhouse can expect to earn \$59,656 in profits from the produce sold. To assess the feasibility of the proposed greenhouse operation, total costs must be compared against total revenues.

**Table 17:** Total Costs and Revenues Chart

Cost Type	Cost Amount	Revenue Source	Revenue Amount
Start-up Costs	\$139,086.42	Projected Sales	\$59,656
Depreciation*	\$7,078.27	Capital Funding	\$225,000
Consumable Item Costs	\$3,196.17	Growing Forward2	
Fixed Costs	\$23,224.15	Northern Foods Development Program	
Sales Cost	\$1,400	Intern Funding	
<b>Total Cost:</b>	<b>\$173,985.01</b>	<b>Total Revenue:</b>	<b>\$284,656</b>

\*Depreciation is a cost that is kept in savings each year to account for any systems or items that break or must be replaced. The amount is calculated by the item's value and its life expectancy.

Provided a grower is able to raise capital funds from federal, territorial, local and/or private funds, the proposed greenhouse can be feasibly established and even achieve modest profits in the first year. If operations are expanded in subsequent years, the grower can expect profits to increase.



# Part 4: Commercial Greenhouses as Social Enterprises

*Throughout the NWT, there is considerable interest in the wider social benefits that come from growing food locally. Commercial greenhouses can be very successful as a social enterprise that aims equally for commercial success, as well as maximal social benefits for the community.*

## Local Economies

By expanding the availability of locally produced food, a local greenhouse can displace southern imports, keeping money in the local economy and reducing dependence on outside suppliers.

During the growing season, the greenhouse will need to hire and train local people to assist with planting, caring for crops and harvesting. Through partnerships with local agencies, these jobs can offer an opportunity for local youth, Elders, underemployed individuals or marginalized groups to develop specific agriculture and technology skills.

## Healthy Eating Habits

Greenhouse operators have an opportunity to promote their business while also promoting healthy eating. Healthy eating and cooking programs could be developed for the school food program. Hosting field trips at the greenhouse can be an opportunity to introduce children and youth to the basics of growing food. Greenhouse owners may be able to partner with local organizations access agriculture or health funding and coordinate healthy food programing, with excess produce from crops being incorporated into the program budget.

Employees are also a resource for spreading positive eating habits: the influence and knowledge gained through training and work experience could inspire them to choose fresh produce more often and encourage their family and friends to do so as well. When other community members see that fresh produce is turning up on tables and in conversation, they may be interested in trying produce that they had not previously been familiar with. Growers can offer further benefits by offering discounted CSA memberships to employees.

## Sustainable Food Systems

By growing local foods, the greenhouse enterprise supports a locally sustainable food system. This is an important goal for northern communities, whose ties to southern food sources can often be precarious, sometimes relying on a single road that can be closed by forest fires, flooding, or weather.

A local greenhouse can also contribute to improving the local food system by teaching planting and growing in the community. This may be an opportunity to partner with other local organizations to access funds for programming that encourages local growing. The benefit is that community members will have a source of food, should they have limited income, or should usual food markets become unavailable in an emergency.



# Recommendations

*This report aims to provide a plan for a commercial greenhouse in Norman Wells a qualified grower could implement. The following are recommendations derived from the feasibility study.*

## 1. Greenhouse Design

The proposed greenhouse is a 30ft by 72ft by 18ft arched greenhouse with 10ft sidewalls, polycarbonate end walls and double door entryway with a polyethylene glazing.

## 2. Crop Selection

While the greenhouse design allows for plenty of room for expansion, the recommendation is to start with 8 -10 crops: tomatoes, bell peppers, cucumbers, basil, cilantro, thyme, baby spinach, mixed greens, butter lettuce and romaine.

## 3. Growing Schedule

The greenhouse design and proposed crops would be best served by a growing season that starts in April and ends in October.

## 4. Markets

In its first year, the greenhouse is designed to grow enough produce to supply local catering company (Royal Mackenzie Catering) and a weekly Community Supported Agriculture (CSA) box for about twenty members. In future years, the CSA membership can be expanded.

## 5. Heating

Two heating systems have been assessed for feasibility: forced air and radiant heat. If the capital money is available radiant heat is strongly recommended to reduce energy costs.

## 6. Growing System

Hydroponic vertical growing towers and bato buckets are recommended because soil is not a readily available resource in Norman Wells, and shipping enough soil for a greenhouse of this size would be less efficient than growing without soil.

## 7. Bedding Plants

Bedding plants are a great source of revenue, as they are sold early in the year at a profit, leaving room to start other crops. It should be noted that a spring bedding plant sale would compete with the existing commercial greenhouse's spring bedding plant sale.

## 8. Raised Beds

Permafrost zones vary widely in Norman Wells, therefore raised beds would be required for in-ground growing. While there is high demand for root vegetables, like potatoes, carrots, and onions, raised beds are not an efficient growing option for a greenhouse that would have to ship soil.

# APPENDICES

## Appendix A: Customer demand survey results

Statement	Agree OR Strongly Agree	Neutral	Disagree OR Strongly Disagree
Very fresh fruits and vegetables are not usually available for me to buy.	70%	15%	15%
I would be willing to pay a little more for very fresh produce.	66%	16%	18%
I will buy fruits and vegetables wherever they are the cheapest, even if the quality is lower.	8%	17%	75%
I think fruits and vegetables should be grown locally.	58%	33%	10%
I would support a local business that sells fresh fruits and vegetables.	95%	4%	1%

Item	Very Likely & Somewhat likely	Somewhat unlikely & not likely	Never
Annual flowers for pots and planters	57%	35%	8%
Annual flowers for a flower bed	52%	34%	14%
Perennial flowers	57%	31%	12%
Vegetables for a home garden	62%	29%	9%
Vegetables for a home greenhouse	55%	34%	11%
Herbs	77%	17%	94%
Berry bushes	56%	31%	13%
Shrubs for landscaping	28%	56%	16%
Trees for landscaping	28%	54%	18%

Item	Always & often	Seldom & never	Top ten crop?	Top five crop?
Beans	62%	38%		
Beets	43%	57%		
Broccoli	96%	4%	Yes	Yes
Cabbage	57%	43%		
Cauliflower	78%	22%		
Cucumbers	86%	14%		
Carrots	93%	7%	Yes	Yes
Eggplant	22%	78%		
Garlic	82%	18%		
Kale	64%	36%		
Kohlrabi	21%	79%		
Leek	34%	66%		
Lettuce	93%	7%	Yes	
Mixed Greens	95%	5%	Yes	Yes
Onions	94%	6%	Yes	Yes
Peas	80%	20%		
Peppers (bell)	92%	8%	Yes	
Peppers (hot)	55%	45%		
Potatoes	91%	9%	Yes	
Radishes	33%	67%		
Spinach	87%	23%	Yes	
Swiss Chard	30%	60%		
Tomatoes	89%	11%	Yes	
Turnips	54%	46%		
Zucchini	65%	35%		
Strawberries	92%	8%	Yes	Yes
Fresh Herbs	83%	17%		

**Appendix B: Customer reported produce demand**

Institution	Produce Type	Weekly Volumes	Weekly Revenue
Royal Catering Company	Tomatoes	10lbs	\$225
	Bell Peppers	5lbs	\$122
	Cucumbers	16	\$75
	Herbs	13	\$81
	Baby Spinach	8.8	\$150
	Mixed Greens	8.8	\$150
	Butter Lettuce	20	\$100
	Romaine	20	\$100
Mackenzie Mountain School	Tomatoes	4lbs	\$88
	Bell Peppers	2lb	\$48
	Cucumbers	2	\$9
	Herbs	1 bundle	\$6
	Baby Spinach	½ lb	\$8.5
	Mixed Greens	½ lb	\$8.5
	Butter Lettuce	1 head	\$5
	Romaine	1 head	\$5
Ramparts	Tomatoes	10lbs	\$225
	Bell Peppers	5lbs	\$122
	Cucumbers	16	\$75
	Herbs	13	\$81
	Baby Spinach	8.8	\$150
	Mixed Greens	8.8	\$150
	Butter Lettuce	20	\$100
	Romaine	20	\$100
Weekly Veggie Box Deliver (10)	Tomatoes	2lbs * 10 = 20lbs	\$440
	Bell Peppers	.5lb * 10 = 5lbs	\$120
	Cucumbers	10	\$45
	Herbs	2 bundles * 10 = 20	\$120
	Baby Spinach	1/4lb * 10 = 2.5lbs	\$42.50
	Mixed Greens	1/4lb 8 10 = 2.5lbs	\$42.50
	Butter Lettuce	10 heads	\$50
	Romaine	10 heads	\$50

**Appendix C: Projected units-per-week demand for each market**

<b>Royal Catering Company</b>								
<b>CROP</b>	Tomatoes	Peppers	Cucumbers	Herbs	Baby Spinach	Mixed Greens	Butter Lettuce	Romaine
<b>UNIT</b>	Pound	Pound	Fruit	Bundle	Pound	Pound	Head	Head
<b>May</b>								
Week one					8.8lbs	8.8lbs	20	20
Week two					8.8lbs	8.8lbs	20	20
Week three					8.8lbs	8.8lbs	20	20
Week four					8.8lbs	8.8lbs	20	20
<b>June</b>								
Week one				13	8.8lbs	8.8lbs	20	20
Week two				13	8.8lbs	8.8lbs	20	20
Week three				13	8.8lbs	8.8lbs	20	20
Week four				13	8.8lbs	8.8lbs	20	20
<b>July</b>								
Week one	10lbs	5lbs	16	13	8.8lbs	8.8lbs	20	20
Week two	10lbs	5lbs	16	13	8.8lbs	8.8lbs	20	20
Week three	10lbs	5lbs	16	13	8.8lbs	8.8lbs	20	20
Week four	10lbs	5lbs	16	13	8.8lbs	8.8lbs	20	20
<b>Aug</b>								
Week one	10lbs	5lbs	16	13	8.8lbs	8.8lbs	20	20
Week two	10lbs	5lbs	16	13	8.8lbs	8.8lbs	20	20
Week three	10lbs	5lbs	16	13	8.8lbs	8.8lbs	20	20
Week four	10lbs	5lbs	16	13	8.8lbs	8.8lbs	20	20
<b>Sept</b>								
Week one	10lbs	5lbs	16	13	8.8lbs	8.8lbs	20	20
Week two	10lbs	5lbs	16	13	8.8lbs	8.8lbs	20	20
Week three	10lbs	5lbs	16	13	8.8lbs	8.8lbs	20	20
Week four	10lbs	5lbs	16	13	8.8lbs	8.8lbs	20	20
<b>Oct</b>								
Week one	10lbs	5lbs	16	13	8.8lbs	8.8lbs	20	20
Week two	10lbs	5lbs	16	13	8.8lbs	8.8lbs	20	20
Week three	10lbs	5lbs	16	13	8.8lbs	8.8lbs	20	20
Week four	10lbs	5lbs	16	13	8.8lbs	8.8lbs	20	20
<b>TOTAL</b>	<b>160lbs</b>	<b>80lbs</b>	<b>256</b>	<b>260</b>	<b>211lbs</b>	<b>211lbs</b>	<b>480</b>	<b>480</b>

<b>Mackenzie Mountain School</b>								
<b>CROP</b>	Tomatoes	Peppers	Cucumbers	Herbs	Baby Spinach	Mixed Greens	Butter Lettuce	Romaine
<b>UNIT</b>	Pound	Pound	Fruit	Bundle	Pound	Pound	Head	Head
<b>May</b>								
Week one					1/2lb	1/2lb	1	1
Week two					1/2lb	1/2lb	1	1
Week three					1/2lb	1/2lb	1	1
Week four					1/2lb	1/2lb	1	1
<b>June</b>								
Week one				1	1/2lb	1/2lb	1	1
Week two				1	1/2lb	1/2lb	1	1
Week three				1	1/2lb	1/2lb	1	1
Week four				1	1/2lb	1/2lb	1	1
<b>July</b>								
Week one	4lbs	2lbs	2	1	1/2lb	1/2lb	1	1
Week two	4lbs	2lbs	2	1	1/2lb	1/2lb	1	1
Week three	4lbs	2lbs	2	1	1/2lb	1/2lb	1	1
Week four	4lbs	2lbs	2	1	1/2lb	1/2lb	1	1
<b>Aug</b>								
Week one	4lbs	2lbs	2	1	1/2lb	1/2lb	1	1
Week two	4lbs	2lbs	2	1	1/2lb	1/2lb	1	1
Week three	4lbs	2lbs	2	1	1/2lb	1/2lb	1	1
Week four	4lbs	2lbs	2	1	1/2lb	1/2lb	1	1
<b>Sept</b>								
Week one	4lbs	2lbs	2	1	1/2lb	1/2lb	1	1
Week two	4lbs	2lbs	2	1	1/2lb	1/2lb	1	1
Week three	4lbs	2lbs	2	1	1/2lb	1/2lb	1	1
Week four	4lbs	2lbs	2	1	1/2lb	1/2lb	1	1
<b>Oct</b>								
Week one	4lbs	2lbs	2	1	1/2lb	1/2lb	1	1
Week two	4lbs	2lbs	2	1	1/2lb	1/2lb	1	1
Week three	4lbs	2lbs	2	1	1/2lb	1/2lb	1	1
Week four	4lbs	2lbs	2	1	1/2lb	1/2lb	1	1
<b>TOTAL</b>	<b>64lbs</b>	<b>32lbs</b>	<b>32</b>	<b>20</b>	<b>12lbs</b>	<b>12lbs</b>	<b>24</b>	<b>24</b>

<b>Ramparts Grocery</b>								
<b>CROP</b>	Tomatoes	Peppers	Cucumbers	Herbs	Baby Spinach	Mixed Greens	Butter Lettuce	Romaine
<b>UNIT</b>	Pound	Pound	Fruit	Bundle	Pound	Pound	Head	Head
<b>May</b>								
Week one					8.8lbs	8.8lbs	20	20
Week two					8.8lbs	8.8lbs	20	20
Week three					8.8lbs	8.8lbs	20	20
Week four					8.8lbs	8.8lbs	20	20
<b>June</b>								
Week one				13	8.8lbs	8.8lbs	20	20
Week two				13	8.8lbs	8.8lbs	20	20
Week three				13	8.8lbs	8.8lbs	20	20
Week four				13	8.8lbs	8.8lbs	20	20
<b>July</b>								
Week one	10lbs	5lbs	16	13	8.8lbs	8.8lbs	20	20
Week two	10lbs	5lbs	16	13	8.8lbs	8.8lbs	20	20
Week three	10lbs	5lbs	16	13	8.8lbs	8.8lbs	20	20
Week four	10lbs	5lbs	16	13	8.8lbs	8.8lbs	20	20
<b>Aug</b>								
Week one	10lbs	5lbs	16	13	8.8lbs	8.8lbs	20	20
Week two	10lbs	5lbs	16	13	8.8lbs	8.8lbs	20	20
Week three	10lbs	5lbs	16	13	8.8lbs	8.8lbs	20	20
Week four	10lbs	5lbs	16	13	8.8lbs	8.8lbs	20	20
<b>Sept</b>								
Week one	10lbs	5lbs	16	13	8.8lbs	8.8lbs	20	20
Week two	10lbs	5lbs	16	13	8.8lbs	8.8lbs	20	20
Week three	10lbs	5lbs	16	13	8.8lbs	8.8lbs	20	20
Week four	10lbs	5lbs	16	13	8.8lbs	8.8lbs	20	20
<b>Oct</b>								
Week one	10lbs	5lbs	16	13	8.8lbs	8.8lbs	20	20
Week two	10lbs	5lbs	16	13	8.8lbs	8.8lbs	20	20
Week three	10lbs	5lbs	16	13	8.8lbs	8.8lbs	20	20
Week four	10lbs	5lbs	16	13	8.8lbs	8.8lbs	20	20
<b>TOTAL</b>	<b>160lbs</b>	<b>80lbs</b>	<b>256</b>	<b>260</b>	<b>211lbs</b>	<b>211lbs</b>	<b>480</b>	<b>480</b>

Weekly Veggie Box Delivery								
CROP	Tomatoes	Peppers	Cucumbers	Herbs	Baby Spinach	Mixed Greens	Butter Lettuce	Romaine
UNIT	Pound	Pound	Fruit	Bundle	Pound	Pound	Head	Head
<b>May</b>								
Week one					2.5lbs	2.5lbs	10	10
Week two					2.5lbs	2.5lbs	10	10
Week three					2.5lbs	2.5lbs	10	10
Week four					2.5lbs	2.5lbs	10	10
<b>June</b>								
Week one				20	2.5lbs	2.5lbs	10	10
Week two				20	2.5lbs	2.5lbs	10	10
Week three				20	2.5lbs	2.5lbs	10	10
Week four				20	2.5lbs	2.5lbs	10	10
<b>July</b>								
Week one	20lbs	5lbs	10	20	2.5lbs	2.5lbs	10	10
Week two	20lbs	5lbs	10	20	2.5lbs	2.5lbs	10	10
Week three	20lbs	5lbs	10	20	2.5lbs	2.5lbs	10	10
Week four	20lbs	5lbs	10	20	2.5lbs	2.5lbs	10	10
<b>Aug</b>								
Week one	20lbs	5lbs	10	20	2.5lbs	2.5lbs	10	10
Week two	20lbs	5lbs	10	20	2.5lbs	2.5lbs	10	10
Week three	20lbs	5lbs	10	20	2.5lbs	2.5lbs	10	10
Week four	20lbs	5lbs	10	20	2.5lbs	2.5lbs	10	10
<b>Sept</b>								
Week one	20lbs	5lbs	10	20	2.5lbs	2.5lbs	10	10
Week two	20lbs	5lbs	10	20	2.5lbs	2.5lbs	10	10
Week three	20lbs	5lbs	10	20	2.5lbs	2.5lbs	10	10
Week four	20lbs	5lbs	10	20	2.5lbs	2.5lbs	10	10
<b>Oct</b>								
Week one	20lbs	5lbs	10	20	2.5lbs	2.5lbs	10	10
Week two	20lbs	5lbs	10	20	2.5lbs	2.5lbs	10	10
Week three	20lbs	5lbs	10	20	2.5lbs	2.5lbs	10	10
Week four	20lbs	5lbs	10	20	2.5lbs	2.5lbs	10	10
<b>TOTAL</b>	<b>320lbs</b>	<b>80lbs</b>	<b>160</b>	<b>400</b>	<b>60lbs</b>	<b>60lbs</b>	<b>240</b>	<b>240</b>

**Appendix D: Projected units-per-week demand for all markets**

<b>CROP</b>	Tomatoes	Peppers	Cucumbers	Herbs	Baby Spinach	Mixed Greens	Butter Lettuce	Romaine
<b>UNIT TYPE</b>	Pound	Pound	Fruit	Bundle	Pound	Pound	Head	Head
May								
1 <sup>st</sup> Week					20.3	20.3	51	51
2 <sup>nd</sup> Week					20.3	20.3	51	51
3 <sup>rd</sup> Week					20.3	20.3	51	51
4 <sup>th</sup> Week					20.3	20.3	51	51
June								
1 <sup>st</sup> Week				47	20.3	20.3	51	51
2 <sup>nd</sup> Week				47	20.3	20.3	51	51
3 <sup>rd</sup> Week				47	20.3	20.3	51	51
4 <sup>th</sup> Week				47	20.3	20.3	51	51
July								
1 <sup>st</sup> Week	44lbs	17lbs	44	47	20.3	20.3	51	51
2 <sup>nd</sup> Week	44lbs	17lbs	44	47	20.3	20.3	51	51
3 <sup>rd</sup> Week	44lbs	17lbs	44	47	20.3	20.3	51	51
4 <sup>th</sup> Week	44lbs	17lbs	44	47	20.3	20.3	51	51
Aug								
1 <sup>st</sup> Week	44lbs	17lbs	44	47	20.3	20.3	51	51
2 <sup>nd</sup> Week	44lbs	17lbs	44	47	20.3	20.3	51	51
3 <sup>rd</sup> Week	44lbs	17lbs	44	47	20.3	20.3	51	51
4 <sup>th</sup> Week	44lbs	17lbs	44	47	20.3	20.3	51	51
Sept								
1 <sup>st</sup> Week	44lbs	17lbs	44	47	20.3	20.3	51	51
2 <sup>nd</sup> Week	44lbs	17lbs	44	47	20.3	20.3	51	51
3 <sup>rd</sup> Week	44lbs	17lbs	44	47	20.3	20.3	51	51
4 <sup>th</sup> Week	44lbs	17lbs	44	47	20.3	20.3	51	51
Oct								
1 <sup>st</sup> Week	44lbs	17lbs	44	47	20.3	20.3	51	51
2 <sup>nd</sup> Week	44lbs	17lbs	44	47	20.3	20.3	51	51
3 <sup>rd</sup> Week	44lbs	17lbs	44	47	20.3	20.3	51	51
4 <sup>th</sup> Week	44lbs	17lbs	44	47	20.3	20.3	51	51
<b>TOTAL</b>	<b>704lbs</b>	<b>272</b>	<b>704</b>	<b>940</b>	<b>487.2</b>	<b>487.2</b>	<b>1224</b>	<b>1224</b>

## Appendix E: Space requirement by crop

\*space requirements are rounded up to non-decimal values

Tomatoes					
Harvest Date: May	Units Harvested	RPB	YPF	GA Per Harvest	Monthly GA Required
1 <sup>st</sup> Week	44lbs	1	2.64lb/ft2	17ft	68ft
2 <sup>nd</sup> Week	44lbs	1	2.64lb/ft2	17ft	
3 <sup>rd</sup> Week	44lbs	1	2.64lb/ft2	17ft	
4 <sup>th</sup> Week	44lbs	1	2.64lb/ft2	17ft	
Harvest Date: June	Units Harvested	RPB	YPF	GA Per Harvest	Monthly GA Required
1 <sup>st</sup> Week	44lbs	1	2.64lb/ft2	17ft	68ft
2 <sup>nd</sup> Week	44lbs	1	2.64lb/ft2	17ft	
3 <sup>rd</sup> Week	44lbs	1	2.64lb/ft2	17ft	
4 <sup>th</sup> Week	44lbs	1	2.64lb/ft2	17ft	
Harvest Date: July	Units Harvested	RPB	YPF	GA Per Harvest	Monthly GA Required
1 <sup>st</sup> Week	44lbs	1	2.64lb/ft2	17ft	68ft
2 <sup>nd</sup> Week	44lbs	1	2.64lb/ft2	17ft	
3 <sup>rd</sup> Week	44lbs	1	2.64lb/ft2	17ft	
4 <sup>th</sup> Week	44lbs	1	2.64lb/ft2	17ft	
Harvest Date: August	Units Harvested	RPB	YPF	GA Per Harvest	Monthly GA Required
1 <sup>st</sup> Week	44lbs	1	2.64lb/ft2	17ft	68ft
2 <sup>nd</sup> Week	44lbs	1	2.64lb/ft2	17ft	
3 <sup>rd</sup> Week	44lbs	1	2.64lb/ft2	17ft	
4 <sup>th</sup> Week	44lbs	1	2.64lb/ft2	17ft	

Bell Peppers					
Harvest Date: May	Units Harvested	RPB	YPF	GA Per Harvest	Monthly GA Required
1 <sup>st</sup> Week	17lbs	1	.6lb/ft2	29ft	116ft
2 <sup>nd</sup> Week	17lbs	1	.6lb/ft2	29ft	
3 <sup>rd</sup> Week	17lbs	1	.6lb/ft2	29ft	
4 <sup>th</sup> Week	17lbs	1	.6lb/ft2	29ft	
Harvest Date: June	Units Harvested	RPB	YPF	GA Per Harvest	Monthly GA Required
1 <sup>st</sup> Week	17lbs	1	.6lb/ft2	29ft	116ft
2 <sup>nd</sup> Week	17lbs	1	.6lb/ft2	29ft	
3 <sup>rd</sup> Week	17lbs	1	.6lb/ft2	29ft	
4 <sup>th</sup> Week	17lbs	1	.6lb/ft2	29ft	
Harvest Date: July	Units Harvested	RPB	YPF	GA Per Harvest	Monthly GA Required
1 <sup>st</sup> Week	17lbs	1	.6lb/ft2	29ft	116ft
2 <sup>nd</sup> Week	17lbs	1	.6lb/ft2	29ft	
3 <sup>rd</sup> Week	17lbs	1	.6lb/ft2	29ft	
4 <sup>th</sup> Week	17lbs	1	.6lb/ft2	29ft	
Harvest Date: August	Units Harvested	RPB	YPF	GA Per Harvest	Monthly GA Required
1 <sup>st</sup> Week	17lbs	1	.6lb/ft2	29ft	116ft
2 <sup>nd</sup> Week	17lbs	1	.6lb/ft2	29ft	
3 <sup>rd</sup> Week	17lbs	1	.6lb/ft2	29ft	
4 <sup>th</sup> Week	17lbs	1	.6lb/ft2	29ft	

**Cucumbers**

Harvest Date: July	Units Harvested	RPB	YPF	GA Per Harvest	Monthly GA Required
1 <sup>st</sup> Week	44	1	5 fruit/ft	9ft	36ft
2 <sup>nd</sup> Week	44	1	5 fruit/ft	9ft	
3 <sup>rd</sup> Week	44	1	5 fruit/ft	9ft	
4 <sup>th</sup> Week	44	1	5 fruit/ft	9ft	
Harvest Date: Aug	Units Harvested	RPB	YPF	GA Per Harvest	Monthly GA Required
1 <sup>st</sup> Week	44	1	5 fruit/ft	9ft	36ft
2 <sup>nd</sup> Week	44	1	5 fruit/ft	9ft	
3 <sup>rd</sup> Week	44	1	5 fruit/ft	9ft	
4 <sup>th</sup> Week	44	1	5 fruit/ft	9ft	
Harvest Date: Sept	Units Harvested	RPB	YPF	GA Per Harvest	Monthly GA Required
1 <sup>st</sup> Week	44	1	5 fruit/ft	9ft	36ft
2 <sup>nd</sup> Week	44	1	5 fruit/ft	9ft	
3 <sup>rd</sup> Week	44	1	5 fruit/ft	9ft	
4 <sup>th</sup> Week	44	1	5 fruit/ft	9ft	
Harvest Date: Oct	Units Harvested	RPB	YPF	GA Per Harvest	Monthly GA Required
1 <sup>st</sup> Week	44	1	5 fruit/ft	9ft	36ft
2 <sup>nd</sup> Week	44	1	5 fruit/ft	9ft	
3 <sup>rd</sup> Week	44	1	5 fruit/ft	9ft	
4 <sup>th</sup> Week	44	1	5 fruit/ft	9ft	

**Herbs**

Harvest Date: June	Units Harvested	RPB	YPF	GA Per Harvest	Monthly GA Required
1 <sup>st</sup> Week	47	1	2 bundles/ft	24ft/8ft = 3 towers	96ft of vertical growing area = 12 towers per month = 12 * 4ft2 = 48ft2
2 <sup>nd</sup> Week	47	1	2 bundles/ft	24ft/8ft = 3 towers	
3 <sup>rd</sup> Week	47	1	2 bundles/ft	24ft/8ft = 3 towers	
4 <sup>th</sup> Week	47	1	2 bundles/ft	24ft/8ft = 3 towers	
Harvest Date: July	Units Harvested	RPB	YPF	GA Per Harvest	Monthly GA Required
1 <sup>st</sup> Week	47	1	2 bundles/ft	24ft/8ft = 3 towers	96ft of vertical growing area = 12 towers per month = 12 * 4ft2 = 48ft2
2 <sup>nd</sup> Week	47	1	2 bundles/ft	24ft/8ft = 3 towers	
3 <sup>rd</sup> Week	47	1	2 bundles/ft	24ft/8ft = 3 towers	
4 <sup>th</sup> Week	47	1	2 bundles/ft	24ft/8ft = 3 towers	
Harvest Date: Aug	Units Harvested	RPB	YPF	GA Per Harvest	Monthly GA Required
1 <sup>st</sup> Week	47	1	2 bundles/ft	24ft/8ft = 3 towers	96ft of vertical growing area = 12 towers per month = 12 * 4ft2 = 48ft2
2 <sup>nd</sup> Week	47	1	2 bundles/ft	24ft/8ft = 3 towers	
3 <sup>rd</sup> Week	47	1	2 bundles/ft	24ft/8ft = 3 towers	
4 <sup>th</sup> Week	47	1	2 bundles/ft	24ft/8ft = 3 towers	
Harvest Date: Sept	Units Harvested	RPB	YPF	GA Per Harvest	Monthly GA Required
1 <sup>st</sup> Week	47	1	2 bundles/ft	24ft/8ft = 3 towers	96ft of vertical growing area = 12 towers per month = 12 * 4ft2 = 48ft2
2 <sup>nd</sup> Week	47	1	2 bundles/ft	24ft/8ft = 3 towers	
3 <sup>rd</sup> Week	47	1	2 bundles/ft	24ft/8ft = 3 towers	
4 <sup>th</sup> Week	47	1	2 bundles/ft	24ft/8ft = 3 towers	
Harvest Date: Oct	Units Harvested	RPB	YPF	GA Per Harvest	Monthly GA Required
1 <sup>st</sup> Week	47	1	2 bundles/ft	24ft/8ft = 3 towers	96ft of vertical growing area = 12 towers per month = 12 * 4ft2 = 48ft2
2 <sup>nd</sup> Week	47	1	2 bundles/ft	24ft/8ft = 3 towers	
3 <sup>rd</sup> Week	47	1	2 bundles/ft	24ft/8ft = 3 towers	
4 <sup>th</sup> Week	47	1	2 bundles/ft	24ft/8ft = 3 towers	

## Baby Spinach

Harvest Date: May	Units Harvested	RPB	YPF	GA Per Harvest	Monthly GA Required
1 <sup>st</sup> Week	24	1	.5lb/ft	48ft/8ft = 6 towers	192ft of vertical
2 <sup>nd</sup> Week	24	1	.5lb/ft	48ft/8ft = 6 towers	growing area =
3 <sup>rd</sup> Week	24	1	.5lb/ft	48ft/8ft = 6 towers	24 towers per month =
4 <sup>th</sup> Week	24	1	.5lb/ft	48ft/8ft = 6 towers	24 * 4ft2 = 96ft2
Harvest Date: June	Units Harvested	RPB	YPF	GA Per Harvest	Monthly GA Required
1 <sup>st</sup> Week	24	1	.5lb/ft	48ft/8ft = 6 towers	192ft of vertical
2 <sup>nd</sup> Week	24	1	.5lb/ft	48ft/8ft = 6 towers	growing area =
3 <sup>rd</sup> Week	24	1	.5lb/ft	48ft/8ft = 6 towers	24 towers per month =
4 <sup>th</sup> Week	24	1	.5lb/ft	48ft/8ft = 6 towers	24 * 4ft2 = 96ft2
Harvest Date: July	Units Harvested	RPB	YPF	GA Per Harvest	Monthly GA Required
1 <sup>st</sup> Week	24	1	.5lb/ft	48ft/8ft = 6 towers	192ft of vertical
2 <sup>nd</sup> Week	24	1	.5lb/ft	48ft/8ft = 6 towers	growing area =
3 <sup>rd</sup> Week	24	1	.5lb/ft	48ft/8ft = 6 towers	24 towers per month =
4 <sup>th</sup> Week	24	1	.5lb/ft	48ft/8ft = 6 towers	24 * 4ft2 = 96ft2
Harvest Date: Aug	Units Harvested	RPB	YPF	GA Per Harvest	Monthly GA Required
1 <sup>st</sup> Week	24	1	.5lb/ft	48ft/8ft = 6 towers	192ft of vertical
2 <sup>nd</sup> Week	24	1	.5lb/ft	48ft/8ft = 6 towers	growing area =
3 <sup>rd</sup> Week	24	1	.5lb/ft	48ft/8ft = 6 towers	24 towers per month =
4 <sup>th</sup> Week	24	1	.5lb/ft	48ft/8ft = 6 towers	24 * 4ft2 = 96ft2
Harvest Date: Sept	Units Harvested	RPB	YPF	GA Per Harvest	Monthly GA Required
1 <sup>st</sup> Week	24	1	.5lb/ft	48ft/8ft = 6 towers	192ft of vertical
2 <sup>nd</sup> Week	24	1	.5lb/ft	48ft/8ft = 6 towers	growing area =
3 <sup>rd</sup> Week	24	1	.5lb/ft	48ft/8ft = 6 towers	24 towers per month =
4 <sup>th</sup> Week	24	1	.5lb/ft	48ft/8ft = 6 towers	24 * 4ft2 = 96ft2
Harvest Date: Oct	Units Harvested	RPB	YPF	GA Per Harvest	Monthly GA Required
1 <sup>st</sup> Week	24	1	.5lb/ft	48ft/8ft = 6 towers	192ft of vertical
2 <sup>nd</sup> Week	24	1	.5lb/ft	48ft/8ft = 6 towers	growing area =
3 <sup>rd</sup> Week	24	1	.5lb/ft	48ft/8ft = 6 towers	24 towers per month =
4 <sup>th</sup> Week	24	1	.5lb/ft	48ft/8ft = 6 towers	24 * 4ft2 = 96ft2

Mixed Greens					
Harvest Date: May	Units Harvested	RPB	YPF	GA Per Harvest	Monthly GA Required
1 <sup>st</sup> Week	24	1	.5lb/ft	48ft/8ft = 6 towers	192ft of vertical
2 <sup>nd</sup> Week	24	1	.5lb/ft	48ft/8ft = 6 towers	growing area =
3 <sup>rd</sup> Week	24	1	.5lb/ft	48ft/8ft = 6 towers	24 towers per month =
4 <sup>th</sup> Week	24	1	.5lb/ft	48ft/8ft = 6 towers	24 * 4ft <sup>2</sup> = 96ft <sup>2</sup>
Harvest Date: June	Units Harvested	RPB	YPF	GA Per Harvest	Monthly GA Required
1 <sup>st</sup> Week	24	1	.5lb/ft	48ft/8ft = 6 towers	192ft of vertical
2 <sup>nd</sup> Week	24	1	.5lb/ft	48ft/8ft = 6 towers	growing area =
3 <sup>rd</sup> Week	24	1	.5lb/ft	48ft/8ft = 6 towers	24 towers per month =
4 <sup>th</sup> Week	24	1	.5lb/ft	48ft/8ft = 6 towers	24 * 4ft <sup>2</sup> = 96ft <sup>2</sup>
Harvest Date: July	Units Harvested	RPB	YPF	GA Per Harvest	Monthly GA Required
1 <sup>st</sup> Week	24	1	.5lb/ft	48ft/8ft = 6 towers	192ft of vertical
2 <sup>nd</sup> Week	24	1	.5lb/ft	48ft/8ft = 6 towers	growing area =
3 <sup>rd</sup> Week	24	1	.5lb/ft	48ft/8ft = 6 towers	24 towers per month =
4 <sup>th</sup> Week	24	1	.5lb/ft	48ft/8ft = 6 towers	24 * 4ft <sup>2</sup> = 96ft <sup>2</sup>
Harvest Date: Aug	Units Harvested	RPB	YPF	GA Per Harvest	Monthly GA Required
1 <sup>st</sup> Week	24	1	.5lb/ft	48ft/8ft = 6 towers	192ft of vertical
2 <sup>nd</sup> Week	24	1	.5lb/ft	48ft/8ft = 6 towers	growing area =
3 <sup>rd</sup> Week	24	1	.5lb/ft	48ft/8ft = 6 towers	24 towers per month =
4 <sup>th</sup> Week	24	1	.5lb/ft	48ft/8ft = 6 towers	24 * 4ft <sup>2</sup> = 96ft <sup>2</sup>
Harvest Date: Sept	Units Harvested	RPB	YPF	GA Per Harvest	Monthly GA Required
1 <sup>st</sup> Week	24	1	.5lb/ft	48ft/8ft = 6 towers	192ft of vertical
2 <sup>nd</sup> Week	24	1	.5lb/ft	48ft/8ft = 6 towers	growing area =
3 <sup>rd</sup> Week	24	1	.5lb/ft	48ft/8ft = 6 towers	24 towers per month =
4 <sup>th</sup> Week	24	1	.5lb/ft	48ft/8ft = 6 towers	24 * 4ft <sup>2</sup> = 96ft <sup>2</sup>
Harvest Date: Oct	Units Harvested	RPB	YPF	GA Per Harvest	Monthly GA Required
1 <sup>st</sup> Week	24	1	.5lb/ft	48ft/8ft = 6 towers	192ft of vertical
2 <sup>nd</sup> Week	24	1	.5lb/ft	48ft/8ft = 6 towers	growing area =
3 <sup>rd</sup> Week	24	1	.5lb/ft	48ft/8ft = 6 towers	24 towers per month =
4 <sup>th</sup> Week	24	1	.5lb/ft	48ft/8ft = 6 towers	24 * 4ft <sup>2</sup> = 96ft <sup>2</sup>

<b>Butter Lettuce</b>					
Harvest Date: May	Units Harvested	RPB	YPF	GA Per Harvest	Monthly GA Required
1 <sup>st</sup> Week	51	1	2 heads/ft	26ft/8ft = 4 towers	104ft of vertical
2 <sup>nd</sup> Week	51	1	2 heads/ft	26ft/8ft = 4 towers	growing area =
3 <sup>rd</sup> Week	51	1	2 heads/ft	26ft/8ft = 4 towers	16 towers a month =
4 <sup>th</sup> Week	51	1	2 heads/ft	26ft/8ft = 4 towers	16 * 4ft <sup>2</sup> = 64ft <sup>2</sup>
Harvest Date: June	Units Harvested	R1PB	YPF	GA Per Harvest	Monthly GA Required
1 <sup>st</sup> Week	51	1	2 heads/ft	26ft/8ft = 4 towers	104ft of vertical
2 <sup>nd</sup> Week	51	1	2 heads/ft	26ft/8ft = 4 towers	growing area =
3 <sup>rd</sup> Week	51	1	2 heads/ft	26ft/8ft = 4 towers	16 towers a month =
4 <sup>th</sup> Week	51	1	2 heads/ft	26ft/8ft = 4 towers	16 * 4ft <sup>2</sup> = 64ft <sup>2</sup>
Harvest Date: July	Units Harvested	RPB	YPF	GA Per Harvest	Monthly GA Required
1 <sup>st</sup> Week	51	1	2 heads/ft	26ft/8ft = 4 towers	104ft of vertical
2 <sup>nd</sup> Week	51	1	2 heads/ft	26ft/8ft = 4 towers	growing area =
3 <sup>rd</sup> Week	51	1	2 heads/ft	26ft/8ft = 4 towers	16 towers a month =
4 <sup>th</sup> Week	51	1	2 heads/ft	26ft/8ft = 4 towers	16 * 4ft <sup>2</sup> = 64ft <sup>2</sup>
Harvest Date: Aug	Units Harvested	RPB	YPF	GA Per Harvest	Monthly GA Required
1 <sup>st</sup> Week	51	1	2 heads/ft	26ft/8ft = 4 towers	104ft of vertical
2 <sup>nd</sup> Week	51	1	2 heads/ft	26ft/8ft = 4 towers	growing area =
3 <sup>rd</sup> Week	51	1	2 heads/ft	26ft/8ft = 4 towers	16 towers a month =
4 <sup>th</sup> Week	51	1	2 heads/ft	26ft/8ft = 4 towers	16 * 4ft <sup>2</sup> = 64ft <sup>2</sup>
Harvest Date: Sept	Units Harvested	RPB	YPF	GA Per Harvest	Monthly GA Required
1 <sup>st</sup> Week	51	1	2 heads/ft	26ft/8ft = 4 towers	104ft of vertical
2 <sup>nd</sup> Week	51	1	2 heads/ft	26ft/8ft = 4 towers	growing area =
3 <sup>rd</sup> Week	51	1	2 heads/ft	26ft/8ft = 4 towers	16 towers a month =
4 <sup>th</sup> Week	51	1	2 heads/ft	26ft/8ft = 4 towers	16 * 4ft <sup>2</sup> = 64ft <sup>2</sup>
Harvest Date: Oct	Units Harvested	RPB	YPF	GA Per Harvest	Monthly GA Required
1 <sup>st</sup> Week	51	1	2 heads/ft	26ft/8ft = 4 towers	104ft of vertical
2 <sup>nd</sup> Week	51	1	2 heads/ft	26ft/8ft = 4 towers	growing area =
3 <sup>rd</sup> Week	51	1	2 heads/ft	26ft/8ft = 4 towers	16 towers a month =
4 <sup>th</sup> Week	51	1	2 heads/ft	26ft/8ft = 4 towers	16 * 4ft <sup>2</sup> = 64ft <sup>2</sup>

<b>Romaine</b>					
Harvest Date: May	Units Harvested	RPB	YPF	GA Per Harvest	Monthly GA Required
1 <sup>st</sup> Week	51	1	2 heads/ft	26ft/8ft = 4 towers	104ft of vertical
2 <sup>nd</sup> Week	51	1	2 heads/ft	26ft/8ft = 4 towers	growing area =
3 <sup>rd</sup> Week	51	1	2 heads/ft	26ft/8ft = 4 towers	16 towers a month =
4 <sup>th</sup> Week	51	1	2 heads/ft	26ft/8ft = 4 towers	16 * 4ft <sup>2</sup> = 64ft <sup>2</sup>
Harvest Date: June	Units Harvested	RPB	YPF	GA Per Harvest	Monthly GA Required
1 <sup>st</sup> Week	51	1	2 heads/ft	26ft/8ft = 4 towers	104ft of vertical
2 <sup>nd</sup> Week	51	1	2 heads/ft	26ft/8ft = 4 towers	growing area =
3 <sup>rd</sup> Week	51	1	2 heads/ft	26ft/8ft = 4 towers	16 towers a month =
4 <sup>th</sup> Week	51	1	2 heads/ft	26ft/8ft = 4 towers	16 * 4ft <sup>2</sup> = 64ft <sup>2</sup>
Harvest Date: July	Units Harvested	RPB	YPF	GA Per Harvest	Monthly GA Required
1 <sup>st</sup> Week	51	1	2 heads/ft	26ft/8ft = 4 towers	104ft of vertical
2 <sup>nd</sup> Week	51	1	2 heads/ft	26ft/8ft = 4 towers	growing area =
3 <sup>rd</sup> Week	51	1	2 heads/ft	26ft/8ft = 4 towers	16 towers a month =
4 <sup>th</sup> Week	51	1	2 heads/ft	26ft/8ft = 4 towers	16 * 4ft <sup>2</sup> = 64ft <sup>2</sup>
Harvest Date: Aug	Units Harvested	RPB	YPF	GA Per Harvest	Monthly GA Required
1 <sup>st</sup> Week	51	1	2 heads/ft	26ft/8ft = 4 towers	104ft of vertical
2 <sup>nd</sup> Week	51	1	2 heads/ft	26ft/8ft = 4 towers	growing area =
3 <sup>rd</sup> Week	51	1	2 heads/ft	26ft/8ft = 4 towers	16 towers a month =
4 <sup>th</sup> Week	51	1	2 heads/ft	26ft/8ft = 4 towers	16 * 4ft <sup>2</sup> = 64ft <sup>2</sup>
Harvest Date: Sept	Units Harvested	RPB	YPF	GA Per Harvest	Monthly GA Required
1 <sup>st</sup> Week	51	1	2 heads/ft	26ft/8ft = 4 towers	104ft of vertical
2 <sup>nd</sup> Week	51	1	2 heads/ft	26ft/8ft = 4 towers	growing area =
3 <sup>rd</sup> Week	51	1	2 heads/ft	26ft/8ft = 4 towers	16 towers a month =
4 <sup>th</sup> Week	51	1	2 heads/ft	26ft/8ft = 4 towers	16 * 4ft <sup>2</sup> = 64ft <sup>2</sup>
Harvest Date: Oct	Units Harvested	RPB	YPF	GA Per Harvest	Monthly GA Required
1 <sup>st</sup> Week	51	1	2 heads/ft	26ft/8ft = 4 towers	104ft of vertical
2 <sup>nd</sup> Week	51	1	2 heads/ft	26ft/8ft = 4 towers	growing area =
3 <sup>rd</sup> Week	51	1	2 heads/ft	26ft/8ft = 4 towers	16 towers a month =
4 <sup>th</sup> Week	51	1	2 heads/ft	26ft/8ft = 4 towers	16 * 4ft <sup>2</sup> = 64ft <sup>2</sup>

## Appendix F: Space Requirements for Seedling Trays

### Crop: Tomato

Planting Month	Monthly GA Req	RPB	IRS	Tray Size	Total Trays	Total ft2/month
May	68ft	1	1ft	50 cell	2 * 1.6ft	4ft2

### Crop: Bell Pepper

Planting Month	Monthly GA Req	RPB	IRS	Tray Size	Total Trays	Total ft2/month
May	116ft	1	1ft	50 cell	3 * 1.6ft	5ft2

### Crop: Cucumber

Planting Month	Monthly GA Req	RPB	IRS	Tray Size	Total Trays	Total ft2/month
May	36ft	1	1.5ft	24 cell	1 * .88ft	1ft2

### Crop: Herbs

Planting Month	Monthly GA Req	RPB	IRS	Tray Size	Total Trays	Total ft2/month
May	96ft	1	.5ft	72 cell	3 * 1.6	5ft2
June	96ft	1	.5ft	72 cell	3 * 1.6	5ft2
July	96ft	1	.5ft	72 cell	3 * 1.6	5ft2
August	96ft	1	.5ft	72 cell	3 * 1.6	5ft2
September	96ft	1	.5ft	72 cell	3 * 1.6	5ft2

### Crop: Baby Spinach

Planting Month	Monthly GA Req	RPB	IRS	Tray Size	Total Trays	Total ft2/month
May	192ft	1	.15ft	72 cell	18 * 1.6ft2	29ft2
June	192ft	1	.15ft	72 cell	18 * 1.6ft2	29ft2
July	192ft	1	.15ft	72 cell	18 * 1.6ft2	29ft2
August	192ft	1	.15ft	72 cell	18 * 1.6ft2	29ft2
September	192ft	1	.15ft	72 cell	18 * 1.6ft2	29ft2

### Crop: Mixed Greens

Planting Month	Monthly GA Req	RPB	IRS	Tray Size	Total Trays	Total ft2/month
May	192ft	1	.15ft	72 cell	18 * 1.6ft2	29ft2
June	192ft	1	.15ft	72 cell	18 * 1.6ft2	29ft2
July	192ft	1	.15ft	72 cell	18 * 1.6ft2	29ft2
August	192ft	1	.15ft	72 cell	18 * 1.6ft2	29ft2
September	192ft	1	.15ft	72 cell	18 * 1.6ft2	29ft2

### Crop: Butter Lettuce

Planting Month	Monthly GA Req	RPB	IRS	Tray Size	Total Trays	Total ft2/month
May	104ft	1	.7ft	50 cell	3 * 1.6	5ft2
June	104ft	1	.7ft	50 cell	3 * 1.6	5ft2
July	104ft	1	.7ft	50 cell	3 * 1.6	5ft2
August	104ft	1	.7ft	50 cell	3 * 1.6	5ft2
September	104ft	1	.7ft	50 cell	3 * 1.6	5ft2

### Crop: Romaine

Planting Month	Monthly GA Req	RPB	IRS	Tray Size	Total Trays	Total ft2/month
May	104ft	1	.7ft	50 cell	3 * 1.6	5ft2
June	104ft	1	.7ft	50 cell	3 * 1.6	5ft2
July	104ft	1	.7ft	50 cell	3 * 1.6	5ft2
August	104ft	1	.7ft	50 cell	3 * 1.6	5ft2
September	104ft	1	.7ft	50 cell	3 * 1.6	5ft2

## Appendix G: Detailed Start-up Costs

Category	Item	Cost*	Projected Lifespan in years	Depreciation **
Greenhouse structure	GrowSpan Series	\$17104.55	50	\$34.30
	End Frame Kit	\$1,588 * 2 = \$3176	10-15	\$317.60
	Clad kit	\$1576.56 * 2 = \$3153.12	10-15	\$315.30
	Rafter kit, posts	\$468.31 * 6 = \$2809.86	10 – 15	\$281
	Rafter Support	\$207.42 * 5 = \$1037.10	10 – 15	\$103.70
	Dbl swinging door	\$859.55	10 – 15	\$86
Growing System	Dutch Bucket System	\$8843	8	\$1105.38
	Integrated Panel	\$2459.45	5	\$492
	Timer	\$65.17	5	\$13.03
	ZipGrow Commercial Bundle	\$9,450	10-20	\$1181.25
	ZipGrow Media pulling hook	\$29.99	5	\$6
Radiant Heating System	In-floor & Bench rubber tubing	\$12,725.60	20+	\$636.28
	Fuel Oil Boiler	\$6,025	20+	\$301.25
Unit Heater	Optional for colder nights	\$1,150.68	15	\$76.71
Ventilation	Fan 20"	\$189.12 * 4 = \$756.48	5	\$151.40
	Slant wall fan	\$1081.64	5	\$216.40
	Aluminum Shutter	\$384.90 * 2 = \$768.80	10 – 15	\$76.90
Irrigation	Seedling watering system	\$200	5	\$40
Workspace	4'w x 8'L Workbenches	\$338.34 * 23 = \$7781.82	10 -15	\$101.47
Storage, Harvest and Processing	Produce Fridge	\$13,087	10 -15	\$1308.70
	Reusable harvest Containers	20 * \$19 = \$380	8	\$47.50
	Reusable harvest Containers	20 * \$19.95 = \$399	8	\$49.87
	Salad Spinner	\$145	8	\$18.13
	S/S Washbasin work surface	\$1181	10 -15	\$118.10
Greenhouse Labour	\$50-\$75 unskilled/skilled labour	260 hrs * \$75 = \$19,500	N/A	N/A
ZipGrow Operations Systems Installation	Upstart Farmers Support Package included	N/A	N/A	N/A
Radiant Heat System Installation	175 man hours – 9-10 days with 2 people working 10 hour days	\$75/hr = \$13,125	N/A	N/A
Shipping	FarmTek	\$9,956		
	ZipGrow Canada	\$400		
	Hendrix Restaurant Supplies	\$335.61		
	Delta Radiant Heating	\$1,100		
Customs		TBD		
<b>Total</b>		<b>\$139,086.42</b>		<b>\$7078.27</b>

### Sales Cost Chart

Sales Costs	Item	Cost
Shipping/Delivery	Gas	\$200/month
Packaging		Fixed Cost, see above
Storage	Produce Fridge	Start-up Cost
Marketing	Use social media	Free
<b>Total Sales Costs</b>		<b>\$200</b>

### Consumables Cost Chart

Consumable Item Cost	Item	Cost
<b>Containers</b>	Seedling trays	$\$2.11 * 20 = \$42.20$
<b>Growing Media (substrate)</b>	Delta 6 Block	$\$5.55 * 46 = \$360.11$
<b>Plugs, cuttings, seed</b>		\$2000
<b>Tags, Stakes, Trellis, Etc.</b>	Trellis Kit	$\$32.55 * 10 = \$325.50$
	Tomato Roller	$\$1.34 * 300 = \$402$
	Tomato Clips	$\$22.12 * 3 = \$66.36$
<b>Fertilizer</b>		Included in first year hydroponic bundles
<b>Chemicals – Pest Control, PGR</b>		Included in first year hydroponic bundles
<b>Total Variable Costs</b>		<b>\$3196.17</b>

## Special thanks

Special thanks to our funders and partners on this project. Photos courtesy of Villiam Svalo of Vineland Research.



Photo Credit: Northern Farm Training Institute

For more information please contact



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